US Army Corps
of Engineers
North Central Division

Great Lakes Update

No. 114 January 4, 1995

1994 Annual Summary

A look back at 1994 shows that the trend of Great Lakes water levels generally followed the seasonal pattern. Water levels of Lakes Superior and Ontario were at or near their long-term averages throughout the year. Lakes Erie and Michigan-Huron water levels started the year above their long-term averages but did not rise to the high mid-year levels that occurred in 1993. Lake Ontario started the year at its long-term average for January and remained near average throughout the year. This is in marked contrast to the extreme highs reached in the spring of 1993.

Precipitation and Temperature

Great Lakes basin air temperatures began 1994 below normal with many areas experiencing severe lows. During the spring, temperatures ranged from below normal to above normal, and during the summer and fall months, were at or above normal over the entire basin. The severe cold temperatures during the winter resulted in an uncharacteristic accumulation of lake ice which varied from a thin sheet in Lake Ontario to several feet on Lake Superior. Frost depths of 8 feet were reported in the Upper Peninsula of Michigan. Milder temperatures during the second half of the winter reduced the ice accumulation slowly thereby avoiding any flooding that could have happened as a result of the spring ice melt.

Precipitation over the Great Lakes for 1994, based on preliminary records from the U.S. National Weather Service and Canadian Atmospheric Environment Service, was near average. Drier periods were experienced in February, March, May, September, October, and December with the remaining months being wetter. Total basin-wide precipitation for 1994 was 31.4 inches, about 0.9 inch below average. Figure 1 compares the monthly precipitation for 1993 and 1994 to the long-term average for the entire basin.

Lake Levels

The *"Monthly Bulletin of Lake*

Great Lakes Basin Precipitation
Deviation from Long-term Average (1900-91)
(1994 Records for July-December are Preliminary)

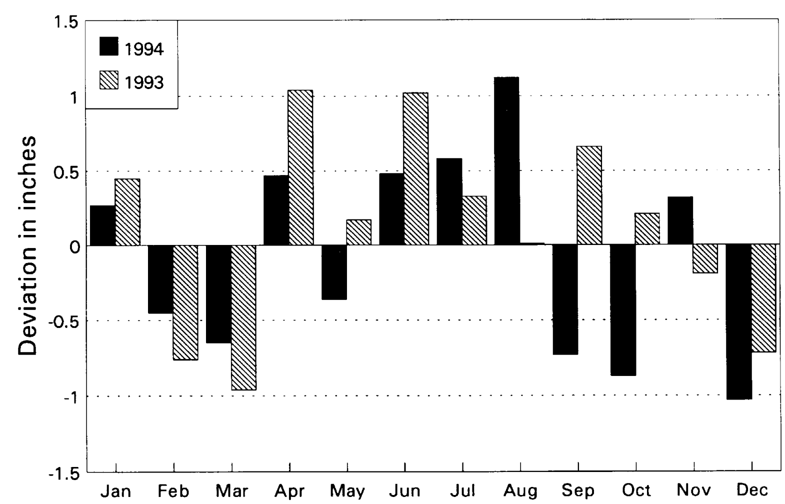

Figure 1

Levels for the Great Lakes", which fosters this Update, graphically shows the fluctuation of water levels on the Great Lakes for the years 1993 and 1994. Generally, the water level of Lake Superior was at or near its average throughout 1994. Lakes Michigan-Huron, St. Clair and Erie water levels were above average for the entire year but followed their usual seasonal patterns. The 1994 water levels of these lakes generally were near or lower than those for comparable months in 1993. Lake Ontario water levels tended to follow the seasonal pattern staying near average during 1994.

During 1994, Lake Superior's water level paralleled its normal seasonal cycle while starting the year about 1.5 inches above its average. Precipitation for the year was below average but did not appear to significantly affect water levels. Lake Superior's water level ended the year near its December long-term average.

Lakes Michigan-Huron water levels began 1994 about 9 inches above average. Below normal precipitation in the spring may have contributed to a slowing of the lake's normal seasonal rise in June. Monthly average water levels ranged between 5 and 10 inches above average throughout the year, peaking in July and ending the year about 8 inches above average. Although precipitation for the year was above average, it did not significantly affect the overall seasonal pattern. Lake Erie water levels started 1994 about 9 inches above the January long-term average. Water levels followed their seasonal pattern with a slight fall off in June due to below average precipitation in the spring. For 1994, precipitation over the basin was below normal. Monthly average water levels ranged between 8 and 11 inches above average throughout the year, peaking in July and ending the year about 9 inches above the December long-term average.

Lake Ontario water levels were very near the long-term seasonal average throughout the year. The lake started the year at its January long-term average. In general, the mean water levels followed their seasonal pattern ranging from 5 inches below average in March to 4 inches above average in May. The year ended with the water level about 2 inches below the December long-term average.

Storms

The Great Lakes Storm Damage Reporting System (GLSDRS), developed in 1993, was the subject of Update articles in March 1994 (No. 104) and more recently in December 1994 (No. 113). The system was developed by the Chicago District, Corps of Engineers. Field trials were successfully completed in September 1994. The system monitors meteorological data (water levels, wave heights, wind speed and wind direction) in order to identify storm activity on the Great Lakes. Subsequent telephone surveys are conducted to collect damage information for the impacted areas.

During the 1994 calendar year 35 telephone surveys were conducted, yielding 2,829 interviews. Damages reported to structures, contents, vehicles, landscapi-- shore protection, docks, b etc., were estimated at about $455,000. GLSDRS samples ten percent of the affected riparian property owners in affected areas, thus, total damages for 1994 are estimated at about $4.5 million when applied to the entire reaches affected by the storms.

Particularly high storm events were noted during the period November 22-29, 1994 on Lakes Michigan, Erie and Ontario. Typical was the event on Lake Erie at Chautauqua County, New York where continuous storm conditions, lasting from 12 to 24 hours, with westerly winds of 25 to 40 knots and waves from 3 to 10 feet high were experienced.

Lake Superior Regulati

In 1994, the International Lake Superior Board of Control continued to use Regulation Plan 1977-A and Criterion (c) of the Order of Approval as the basis for determining Lake Superior outflows. Criterion (c) states that when the monthly mean level of Lake Superior is below 601.7 feet (IGLD 1985), the outflow cannot be greater than that which would have occurred, at the same elevation, under the outflow conditions which prevailed in 1887. On occasion, other factors will influence the setting of outflows, as they did this past year.

The January 1994 outflow was that determined by Plan 197 Criterion (c) limited the out in February, March and April. An unintentional deviation from the plan flow occurred in May, when ɿir work, being performed in intake canal for the Edison Sault Electric Company's hydropower plant on the St. Marys River, required reduced flow through the plant. Work in this canal continued into October. In addition, one generating unit of the U.S. Government's hydropower plant at the St. Marys Falls Canal (Soo Locks) was shut down in August for long-term repairs, further reducing the overall outflow capacity of the hydropower plants. To accommodate these repair efforts, the IJC approved minor deviations from plan flows from June through October. The deviations reduced the outflow from Lake Superior below that specified by Plan 1977-A by an average of 5,000 cubic feet per ɔnd (cfs) per month. By the of October, the effect of these deviations had raised Lake Superior's level about 1 inch, and lowered the level of Lakes Michigan-Huron 1/2 inch.

The outflow in November was that specified by Plan 1977-A, but in December the outflow again deviated from plan. However, this time the IJC authorized an outflow greater than called for by the regulation plan to compensate in part for the expected decrease in outflow capacity due to continuing power plant maintenance programs through next summer.

Figure 2 compares the monthly Lake Superior outflows in 1994 to the long-term average flows. Note that the outflows were above average from January through June, below average from July through November, and above average again in December.

Flow changes resulting from the monthly regulation of Lake Superior are accomplished by varying the amount of water allocated to hydropower production, and, when necessary, by opening or closing gates in the Compensating Works at the head of the St. Marys Rapids. To satisfy the minimum water requirements for the fish habitat in the rapids, at least a 1/2 gate open setting plus an additional 500 cfs of water through the north-most gate (Gate No.1) are maintained. In 1994, to meet the total Lake Superior outflow requirements in May, June and July, one full gate was open in the Compensating Works during those months, in addition to the partially open Gate No.1.

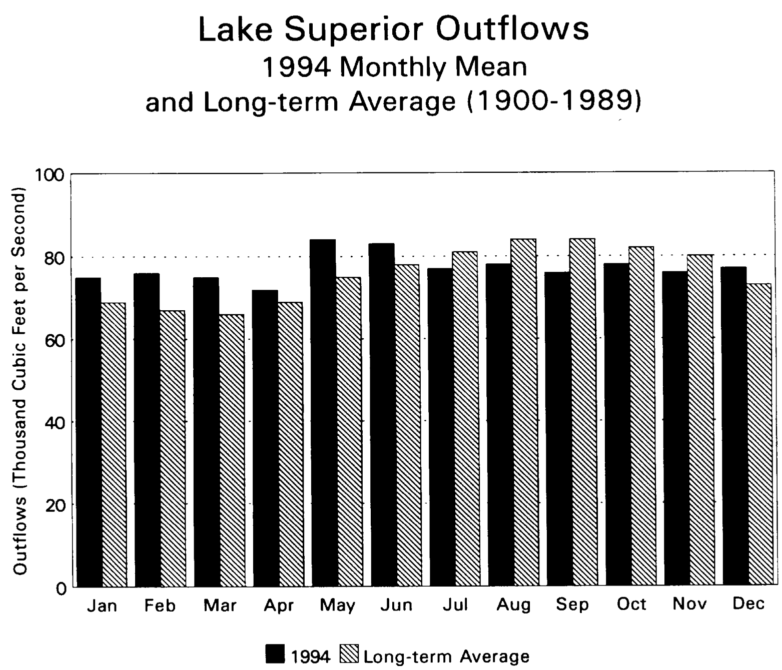

Figure 2

Lake Ontario Regulation

As stated previously, the winter of 1993-94 was severe, characterized by extreme cold and large amounts of snow around the lower Great Lakes. Outflow reductions for Lake Ontario took place for short durations, in late December 1993 to promote formation of an ice cover in the Beauharnois Canal (near Montreal Harbor), and in early January to establish a stable ice cover in the international reach of the St. Lawrence River.

Due to the severe ice conditions in the Lake Ontario-St. Lawrence River System, there were concerns that a rapid snowmelt or ice break-up would result in serious shore damages and possible ice jams. However, a gradual return to mild weather in March resulted in relatively slow melting of ice and snow in the basin and river. There were no reports of serious damages. Outflow reductions were made for a short time in April to prevent downstream flooding during the Ottawa River freshet.

Lake Ontario Outflows
1994 Monthly Mean
and Long-term Average (1900-1990)

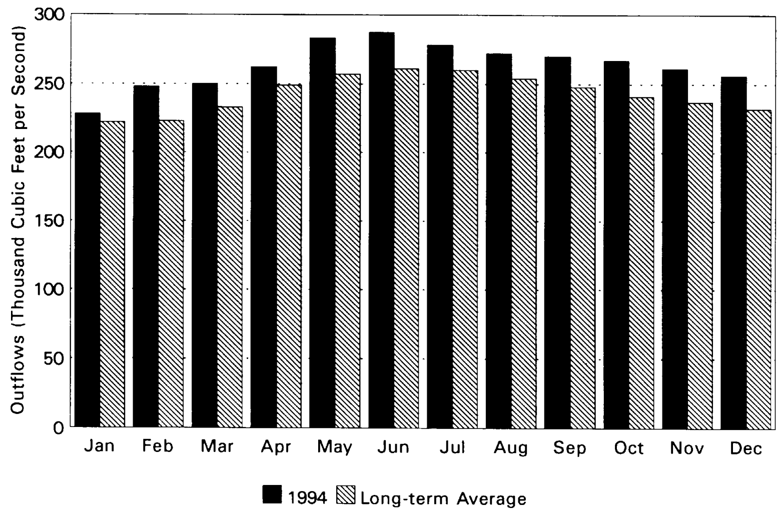

Figure 3

Minor outflow deviations were also made beginning in May and continuing throughout the summer at the request of hydropower interests. (This was from energy-producing capacity exceeding demand in other portions of the electricity-distribution grid. It is easier, and more economical to consumers, to temporarily curtail hydropower production for a day or two than to curtail, say, nuclear production.) These resulted in outflows somewhat less than plan. About 2.4 inches of water was stored on Lake Ontario by summer's end due to these deviations. In addition, the International St. Lawrence River Board of Control approved a temporary outflow reduction in October to provide more favorable water levels for recreational boating on the upper St. Lawrence River. All of these outflow deviations from the Lake Ontario regulation plan, 1958-D, were possible since they did not adversely affect other interests.

Lake Ontario outflows were above average every month throughout the year. Figure 3 shows a comparison of 1994 monthly outflows with the long-term average monthly outflows.

With the exception of January 1994, net total supplies to Lake Ontario were above average for all months of the year; they varied from 225,000 cfs in January to 362,000 cfs in April.

Throughout the year, the St. Lawrence Board and its Working Committee discussed studies of improved regulation of Lake Ontario. Two plans, referred to as Plan 35P and the Interest Satisfaction Model, are presently being considered. The IJC has approved the Board's simulating the use of these plans for a three-year period beginning in early 1994 in order to assess if either plan is an improvement over Plan 1958-D.

Few complaints were received from interests throughout the year, except for some recreational boaters who felt the levels in Septe ber were too low in the Thousa Islands area of the St. Lawrence River.

Meetings With The Public

A meeting of the International St. Lawrence River Board of Control with the public was held in Oswego, New York on June 21, 1994. Both riparian and recreational boaters were well represented. Meetings with the public were also held by the International Lake Superior Board of Control on June 14, 1994 at Duluth, Minnesota and by the International Niagara Board of Control on March 23, 1994 at Niagara Falls, New York.

Commercial Navigation

As of November 1994, tonnage passing through the Soo Locks at Sault Ste. Marie, Michigan was only 0.4% below the comparable tonnage for 1993. United States and Canadian vessels carried about 54 and 15 million short tons of cargo, respectively, while foreign vessels carried about 4 million short tons. Through November 1994, a total of 3,804 cargo vessels had transited the locks as compared to 3,824 passages the previous year. Of these, 2,252 passages were U.S.-flagged vessels, 1,108 were Canadian-flagged, and 444 were foreign vessels (ocean-going or "salties"). In addition to the cargo vessels, there were also 6,785 transits ' other types of vessels, such

Figure 4. Soo Locks - FEDERAL THAMES (Cyprus) at left, upbound through the MacArthur Lock and 1,000 ft self-unloader JAMES R. BARKER at right, down-bound through the Poe Lock. *(Soo Area Office Photo by Carmen Paris.)*

pleasure craft, Coast Guard, and scientific/research vessels. This was 107 transits more than in 1993. The Corps has the authority to keep the locks open until January 15, so long as the shipping interests request late closing, which they have requested again this year. Figure 4 shows the passage of vessels at the Soo Locks.

According to the St. Lawrence Seaway Development Corporation's preliminary figures, 38.4 million metric tons (MMT) of cargo moved through the Lake Ontario-Montreal section of the Seaway in 1994. This was 6.5 MMT more than in 1993. As of December 14, 1994, the yearly total vessel transits were 2,745 (1,527 lakers and 1,218 ocean vessels). Vessel traffic was up 23½ % from 1993.

Seaway officials reported preliminary information on a number of individual cargos during the 1994 season including: iron ore (up 11.2% to 11.1 MMT); grain (up 22.5% to 13.3 MMT); coal (up 131% to 0.6 MMT); and, petroleum products (up 44.8% to 1.4 MMT).

Levels Reference Study Recommendations

On March 31, 1994 the International Joint Commission (IJC) released its report to the Governments of Canada and the United States. It recommended a range of actions to alleviate the adverse consequences of fluctuating water levels on the Great Lakes-St. Lawrence River Basin. These recommendations were based on the studies by its Levels Reference Study Board, Citizen Advisory Committee, Project Management Team and Great Lakes Water Levels Task Force as well as extensive public consultation.

In general, the IJC's report recommended that the Governments promote shoreline management measures as the principal component of a strategy to reduce flooding and erosion losses. Building of additional dams and control works to further regulate levels and flows was not recommended. The IJC's report and recommendations were the subject of the May 3, 1994 Great Lakes Update (No. 106) article, "International Joint Commission's Report on the Great Lakes-St. Lawrence River Water Levels Reference Study".

Future Update Topics

The Corps of Engineers trusts that these Great Lakes Updates are of interest to the readers and are providing a useful service of disseminating information on the Great Lakes Basin. Figure 5 lists the Updates in 1994. We would like to hear any suggestions that you may have on topics that could be addressed in future Updates. Please send your suggestions to the Detroit District, at the address shown at the end of this Update. We look forward to hearing from you and will strive for even more interesting and insightful articles in the future.

RICHARD W. CRAIG
Colonel, EN
Commanding

Figure 5 - 1994 Great Lakes Updates

In 1994, the bulletin provided monthly updates on various Great lakes - St. Lawrence River topics. For 1994, these were as follows:

January	- 1993 Annual Summary, No. 102	**July**	- The Port of Detroit, No. 108
February	- Guide to The Monthly Water Level Bulletin, No. 103	**August**	- Lake Superior's Infamous November Storms, No. 109
March	- Great Lakes Storm Damage Reporting System, No. 104	**September**	- Dredged Material Testing & Evaluation, No. 110
April	- The Port of Toledo, No. 105	**October**	- Water Current Meters (Part 1), No. 111
May	- International Joint Commission's Report on the Great Lakes - St. Lawrence River Water Levels Reference Study, No. 106	**November**	- Water Current Meters (Part 2), No. 112
June	- The Rise and Fall of the Great Lakes, No. 107	**December**	- Field Trials Successfully Completed for Great Lakes Storm Damage Reporting System, No. 113

Table 1

Possible Storm Induced Rises (in feet) at Key Locations on the Great Lakes January 1995

Degrees of Possibility

	20%	10%	3%	2%	1%
LAKE SUPERIOR					
Duluth	0.9	1.1	1.3	1.5	1.6
Grand Marais	0.6	0.7	0.7	0.8	0.8
Marquette	0.8	0.9	1.1	1.2	1.3
Ontonagon	0.5	0.7	0.9	1.1	1.3
Point Iroquois	1.2	1.4	1.6	1.8	2.0
Two Harbors	0.7	0.9	1.2	1.5	1.7
LAKE MICHIGAN					
Calumet Harbor	1.6	1.8	2.1	2.3	2.5
Green Bay	1.3	1.6	1.8	2.1	2.3
Holland	0.9	1.1	1.4	1.5	1.7
Kewaunee	0.8	0.8	0.9	1.0	1.0
Ludington	0.9	1.0	1.2	1.3	1.5
Milwaukee	1.0	1.1	1.3	1.5	1.6
Port Inland	1.1	1.6	2.3	2.9	3.5
Sturgeon Bay	0.8	0.9	1.1	1.2	1.3
LAKE HURON					
Detour Village	0.6	0.7	0.8	0.8	0.9
Essexville	1.4	1.8	2.4	2.9	3.3
Harbor Beach	0.6	0.8	1.1	1.4	1.7
Harrisville	0.5	0.6	0.8	0.8	0.9
Lakeport	1.3	1.4	1.6	1.7	1.8
Mackinaw City	0.8	0.9	1.1	1.2	1.3
LAKE ST. CLAIR					
St. Clair Shores	0.7	0.9	1.1	1.2	1.4
LAKE ERIE *					
Barcelona	2.2	2.8	3.4	3.9	4.3
Buffalo	4.7	5.3	5.9	6.3	6.7
Cleveland	1.1	1.3	1.5	1.7	1.9
Erie	2.2	2.4	2.7	2.9	3.0
Fairport	0.7	1.0	1.2	1.5	1.7
Fermi Power Plant	2.1	2.5	3.0	3.4	3.7
Marblehead	1.7	2.2	2.8	3.3	3.8
Sturgeon Point	3.9	4.5	5.1	5.5	5.9
Toledo	2.6	3.1	3.8	4.2	4.7
LAKE ONTARIO					
Cape Vincent	1.0	1.1	1.2	1.3	1.4
Olcott	0.4	0.5	0.6	0.7	0.7
Oswego	0.8	1.0	1.2	1.4	1.6
Rochester	0.4	0.5	0.6	0.6	0.7

* The water surface of Lake Erie has the potential to tilt in strong winds, producing large differentials between the ends of the lake.

Note: The rises shown above, should they occur, would be in addition to the still water levels indicated on the Monthly Bulletin. Values of wave runup are not provided in this table.

Great Lakes Basin Hydrology

During the month of December precipitation was below average on the Lake Superior, Michigan-Huron and Ontario basins while the Lake Erie basin was above average. For the year to date, precipitation on the entire Great Lakes basin is near the average. The net supplies of water to Lakes Superior, Erie and Ontario were above average, while the net supply to Lak Michigan-Huron was below average. Table 2 lists December precipitation and water supply information for all of the Great Lak

In comparison to their long-term (1918-1993) averages, the December monthly mean water level of Lake Superior was at its average, Lakes Michigan-Huron, St. Clair and Erie were 8, 10 and 9 inches above average respectively, while Lake Ontario was 1 inch below its average. Shoreline residents are cautioned to be alert whenever adverse weather conditions exist, as these could cause rapid short-term rises in water levels. Should the lakes approach critically high levels, further information and advice will be provided by the Corps of Engineers.

TABLE 2
GREAT LAKES HYDROLOGY[1]

PRECIPITATION (INCHES)								
BASIN	**DECEMBER**				**YEAR-TO-DATE**			
	1994[2]	**Average** (1900-1991)	**Diff.**	**% of Average**	**1994[2]**	**Average** (1900-1991)	**Diff.**	**% of Average**
Superior	0.7	2.0	-1.3	35	28.3	30.3	-2.0	93
Michigan-Huron	1.0	2.3	-1.3	43	32.1	32.0	0.1	100
Erie	2.7	2.6	0.1	104	32.7	34.9	-2.2	94
Ontario	2.3	2.9	-0.6	79	34.1	35.1	-1.0	97
Great Lakes	1.3	2.4	-1.1	54	31.4	32.3	-0.9	97

LAKE	**DECEMBER WATER SUPPLIES[3] (CFS)**		**DECEMBER OUTFLOW[4] (CFS)**	
	1994[2]	**Average** (1900-1989)	**1994[2]**	**Average** (1900-1989)
Superior	-16,000	-24,000	77,000	73,000
Michigan-Huron	-8,000	29,000	192,000[5]	183,000
Erie	42,000	17,000	212,000[5]	199,000
Ontario	30,000	27,000	256,000	231,000

[1]Values (excluding averages) are based on preliminary computations.
[2]Estimated.
[3]Negative water supply denotes evaporation from lake exceeded runoff from local basin.
[4]Does not include diversions.
[5]Reflects effects of ice/weed retardation in the connecting channels.

CFS = cubic feet per second.

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